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ECL 278

JACK - A MECHANICAL MUGGER?

My phone rang. I answered it to hear the following: Dr. McGowan? This is John Small. I am an attorney with a client who was severely injured using a mechanical jack. I need an engineer to help me with this case. Can you help me?

Written by C. O. Smith, Engineering Consultant,
Terre Haute, Indiana

All names and places have been changed to protect the innocent (or guilty).

The only reasonable reaction is that I don't know if I can help until I know more details. As we talked, he gave me a brief outline of the situation. My response was to the effect that since I was a mechanical engineer with interest and experience in product design with emphasis on safety, I thought I might be able to help him if he sent me more information and a chance to look at the jack.

He responded with a letter, the pertinent part of which follows: "I have a case involving a mechanical jack manufactured by JACK-IT. My client received a severe injury to his face when the jack handle flew up and struck him in the area of his left eye. He suffered fractures of the bones of his face and eventually lost vision in his eye due to foreign bodies in his eye. JACK-IT has been aware that the jack handle has a tendency to fly up violently but has never hired an engineer to investigate the reasons the jack handle flies up nor has it attempted to correct the problem.

" I am particularly interested in using an engineer within a relatively short distance from JACK-IT if possible. I want an engineer to analyze the jack and show how it can be made safer. I believe the analysis of this jack would not be overly burdensome.

"The theory of our case is that this jack is apparently dangerous because the reversing lever can be placed in the lowering position when the jack handle is in a horizontal position. It apparently does not take much force to release the jack handle once the reversing lever has been moved. Once the jack handle is released it can fly up very violently. I am not an engineer but it would seem to me that there could be developed an inexpensive and simple system to keep the jack handle from flying up violently."

It was my understanding that the plaintiff, the injured party - Henry Voter, moved the reversing lever from the UP position to the DOWN position (presumably while the jack handle was "horizontal") and the jack handle "flew up" and hit him in the face.

In due course, John Small sent me the Operating Instructions (a single sheet, 8½ in x 14 in, printed on both sides). Most of the information in the Operating Instructions is reproduced in Exhibit 1. Information not reproduced in Exhibit 1 is a Parts Price List and some auxillary equipment such as a Bumper Lift, Jack Protector, etc.

JACK-IT maintained that a copy of this sheet accompanied every jack shipped from the factory. The sheet was in an envelope which was attached to the jack with a piece of wire. John Small also sent me the jack involved in Henry Voter's injury.

[It might be of interest to know that John Small was located in a fairly well-known city about 1500 miles from my home. JACK-IT was about a one-hour drive.]

[redacted] **JACK**

"SAFETY ALWAYS PAYS"

OPERATING INSTRUCTIONS

FOR YOUR SAFETY, READ THESE INSTRUCTIONS THOROUGHLY BEFORE OPERATING THE JACK.

It is imperative in operating and handling your Jack that certain normal precautions be observed to prevent the possibility of injury or damage to you and your Jack.

OWNER'S and/or OPERATOR'S RESPONSIBILITY:
The owner and/or operator shall have an understanding of these operating instructions before operating the Jack. If the user is not fluent in English, the instructions shall be read to and discussed with the operator in the operator's native language by the purchaser/owner, making sure the operator comprehends contents.

PREPARING THE JACK FOR USE:
Visually inspect the Jack for damaged, loose or missing parts. Perform any required maintenance. LUBRICATE IT AT THE LUBE POINTS SHOWN IN THE DIAGRAM ON REVERSE SIDE. Attention should be given to lubricating Part No. PP-12 (Key 7), Pitman Pin. If the part is not lubricated, continuous use of the Jack could cause deformation of the Part No. 2 (Key 6) Handle Socket and Part No. 3 (Key 9) Pitman. The Climbing Pins, Part No. CP-1 (Key 15) must be lubricated and free from rust and dirt. IF THESE INSTRUCTIONS ARE NOT FOLLOWED, THE JACK COULD BECOME INOPERABLE. The Jack must have lubrication to function properly and give maximum lifting power. Keep all working parts oiled and clean. Keep front and back edges of the upright Steel Standard (Key 3) lightly greased and free from rust. Use any non-flammable cleaning solvent to clean parts, then apply light oil to all working parts.

SAFETY PRECAUTIONS:
FAILURE TO HEED THE FOLLOWING MAY RESULT IN LOSS OF LOAD, DAMAGE TO JACK AND/OR FAILURE RESULTING IN PERSONAL INJURY OR PROPERTY DAMAGE.

BEFORE RAISING ANY OBJECT MAKE SURE THE JACK IS IN A STABLE POSITION. ALWAYS STABILIZE THE LOAD BEFORE LIFTING. MOBILE LOADS MUST BE CHOCKED. WHEN RAISING OR LOWERING A LOAD, KEEP HANDS AWAY FROM THE MOVING PARTS IN THE JACK'S LIFTING MECHANISM. ALWAYS KEEP A FIRM GRIP ON THE STEEL HANDLE OF THE JACK, USING BOTH HANDS, WHEN RAISING OR LOWERING A LOAD. FAILURE TO DO THIS COULD ALLOW THE HANDLE TO MOVE RAPIDLY UPWARD STRIKING THE OPERATOR AND CAUSING POSSIBLE INJURY. ALWAYS PLACE THE STEEL HANDLE IN A VERTICAL FULL UPRIGHT POSITION, PARALLEL TO THE UPRIGHT STEEL STANDARD BEFORE MOVING THE REVERSING LATCH, PART NO. 4 (KEY 20) TO THE LOWERING POSITION. THIS WILL PREVENT THE STEEL HANDLE FROM MOVING UP AND DOWN RAPIDLY AND POSSIBLE INJURY TO THE OPERATOR. WHEN NOT OPERATING THE HANDLE, IT SHOULD BE IN THE FULL UPRIGHT POSITION PARALLEL TO THE UPRIGHT STEEL STANDARD. THE COMPLETE LIFTING NOSE OF THE JACK MUST BE PLACED UNDER THE OBJECT TO BE RAISED. TO RAISE ONE WHEEL OF A VEHICLE, THE USE OF THE BUMPER LIFT WITH THE JACK IS RECOMMENDED FOR ADDITIONAL SAFETY AND EASE OF LIFTING.

NEVER WORK UNDER A RAISED LOAD UNLESS ADDITIONAL SUPPORTS ARE USED WITH THE RAISED LOAD. WHEN WORKING WITH A RAISED LOAD ON THE JACK, ADDITIONAL PRECAUTIONS MUST BE TAKEN BY SLIPPING A 1/2" BOLT THROUGH THE UPRIGHT STEEL STANDARD IMMEDIATELY BELOW THE LIFTING MECHANISM. NEVER PUSH A LIFTED LOAD OFF THE JACK. NEVER SERVICE THE JACK NOR ATTEMPT REPAIRS WHILE THE JACK IS UNDER LOAD.

TO RAISE A LOAD:
Place the Jack in position for use, making certain the base is on a firm, level surface and the upright Steel Standard is in a vertical position. Lift the Reversing Latch, Part No. 4 (Key 20) until it locks in the UP position and raise the lifting mechanism until the lifting nose is completely and securely under the load. It is not necessary to jack up the lifting mechanism step-by-step to the point of lift. Grasp the steel handle firmly with both hands and pump it up and down. The load will be raised on each down stroke of the steel handle. If the upright Steel Standard starts to lean in any direction, lower the load and reposition the Jack to assure stability.

TO LOWER A LOAD:
Hold the steel handle in an upright position against the upright steel standard and move the Reversing Latch, Part No. 4 (Key 20) to the DOWN position. Grasp the steel handle firmly with both hands and pump it up and down and the load will be lowered on each up stroke of the steel handle.

NOTE: THE JACK MUST BE LOADED (100 POUNDS OR MORE) TO LOWER STEP-BY-STEP, OTHERWISE, THE LIFTING MECHANISM WILL AUTOMATICALLY RETURN TO BASE LEVEL.

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Exhibit 1 (page 1 of 4): Initial portion of front side of Operating Instructions allegedly supplied with the jack.

USE AS A CLAMP, WINCH, HOIST:
The Top Clamp-Clevis, Part No. 7 (Key 2) can be turned 90° to the upright Steel Standard and adjusted to any position on the Steel Standard for use as a Clamp. When the Top Clamp-Clevis is in a vertical position (in line with the Steel Standard) at the top of the Steel Standard, it forms a clevis for winching and hoisting. As a winch or hoist, the Jack requires the use of chain for attaching the loads. WORKING LOADS OF THE CHAIN MUST BE GREATER THAN CAPACITY OF JACK.

To protect the lifting nose of the Jack from breakage, the SAFETY SHEAR PIN, Part No. SP-13 (Key 11) is designed to break when the Jack is overloaded. The load on the Jack will not fall when the SAFETY SHEAR PIN breaks, however, the steel handle will descend rapidly.

If the Jack is overloaded and the SAFETY SHEAR PIN breaks, if necessary, until a manufacturer's replacement can be installed, temporarily replace with a 5/16" SAE grade 2 bolt and carefully lower the load to the base level. DO NOT USE THE JACK AGAIN UNTIL THE TEMPORARY BOLT IS REPLACED WITH THE MANUFACTURER'S SAFETY SHEAR PIN, PART NO. SP-13. NEVER, UNDER ANY CIRCUMSTANCES, USE A BOLT OF HIGHER STRENGTH THAN THE SAFETY SHEAR PIN! USE ONLY MANUFACTURER'S PART NO. SP-13, SAFETY SHEAR PIN!!!

MAINTENANCE:
Prior to use or maintenance, a visual Jack inspection shall be made to check for damage, loose or missing parts. If the Jack is damaged, badly worn or operates abnormally, it shall be removed from service.

For extra long wear, the upright Steel Standard can be reversed (end for end). When replacing the lifting mechanism on the Steel Standard, make certain the Climbing Pins, Part No. CP-1 (Key 15) enter the holes of the Steel Standard from the smooth side. Edges of the holes are rough on the back side of the Steel Standard which will prevent the Climbing Pins from functioning properly.

As your Jack becomes older, you may find that the Climbing Pins bind in the holes of the upright Steel Standard and the Jack may not function properly. This could be caused by a build-up of rust on the Climbing Pins, particularly, if the Jack has not been lubricated as set forth in these instructions. To solve this problem, remove all rust from the Climbing Pins and lubricate the Pins thoroughly. If binding still occurs, the Climbing Pin Springs, Part No. CP-3 (Key 14) could be weak and need replacement.

Never substitute replacement parts other than those provided by the manufacturer as materials and specifications on parts must be exact to insure proper and safe operation of the Jack. If unable to obtain Jack replacement parts from a local dealer, you may order direct from the factory at the prices shown on reverse side plus 20% of total amount of order to cover transportation and handling or, if you wish, remove the lifting mechanism from the Steel Standard, remove the Steel Handle and place the lifting mechanism in a carton and forward to Factory Service Department [redacted] via Parcel Post or United Parcel Service, prepaid. Repaired lifting mechanism will be returned to you via either Parcel Post or United Parcel Service, C.O.D. for cost of replacement parts, service and transportation.

STORAGE:
Before storing and after using, raise the Reversing Latch, Part No. 4 (Key 20) until it locks in the UP position. This will prevent damage to the Climbing Pins, Part No. CP-1 (Key 15) and the Cross Pins, Part No. CP-2 (Key 16). When not in use, the working parts of the Jack should be protected from the weather, mud, sand, etc. by covering the Jack with the Jack Protector.

If you have any questions or problems, please feel free to write the manufacturer.

WE HOPE YOU ARE PLEASED
WITH YOUR JACK AND WILL
RECOMMEND IT TO OTHERS

BEFORE USING JACK READ INSTRUCTIONS CAREFULLY

KEEP YOUR INSTRUCTIONS!
SERVICE YOUR JACK!

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Exhibit 1 (page 2 of 4): Continuing portion of front side of Operating Instructions allegedly supplied with the jack.

LIMITED WARRANTY

[redacted] JACK COMPANY warrants the [redacted] JACK for 12 months from date of purchase, only to the original purchaser, against defective materials and workmanship.

The 60" size [redacted] JACK is warranted for no more than 4,000 pounds on the upper one-third (top 20") of the upright Steel Standard.

When the [redacted] JACK is used as a CLAMP, the Top Clamp-Clevis is warranted for maximum capacity of 750 pounds and when used as a WINCH OR HOIST, the Top Clamp-Clevis is warranted for a maximum capacity of 5,000 pounds.

[redacted] JACK COMPANY's obligation under this warranty is limited to the repair or replacement, at its option, of the product or any part thereof when [redacted] JACK COMPANY determines, in good faith, that the defect is due solely to materials and/or workmanship, not resulting from abuse, misuse or lack of maintenance of the Jack and is conditioned upon payment by the purchaser of all transportation costs incident to such repair or replacement. Return the product or parts thereof, transportation prepaid with proof of purchase date, to Factory Service Department, [redacted] JACK COMPANY, [redacted] JACK COMPANY reserves the right to levy any service charges for handling, packaging and refinishing the product or parts thereof.

This warranty does not include the cost of any inconvenience or property damage due to failure of the product, nor does it cover transportation charges, misuse, abuse, accident or similar incident. This warranty gives you specific legal rights and you may also have other rights which vary from state to state.

This warranty replaces all previous warranties and is the only warranty made by [redacted] JACK COMPANY on this product. No other warranties, either verbal or written, are authorized. THIS WARRANTY IS VOID IF THE JACK IS MODIFIED OR USED BEYOND RATED CAPACITY AND IF AN EXTENDER IS USED ON THE STEEL HANDLE.

Exhibit 1 (page 3 of 4): Limited Warranty statement on back side of Operating Instructions allegedly supplied with the jack.

Key No.	Part Name
1	Top clamp clevis bolt
2	Top clamp clevis
3	Steel standard
4	Handle clip
5	Steel handle with cotter pin
6	Handle socket
7	Pitman pin
8	Hex bolt (7/16" x 2 1/4 ")
9	Pitman
10	Small runner
11	Safety shear pin
12	Base plate with cotter pin
14	Climbing pin spring (2 used)
15	Climbing pin (2 used)
16	Cross pin (2 used)
18	Reversing switch
19	Cap screw (5/16" x 1/2" with washer for reversing switch
20	Reversing latch
21	Reversing switch spring
22	Large runner
23	Complete running gear (assembled)

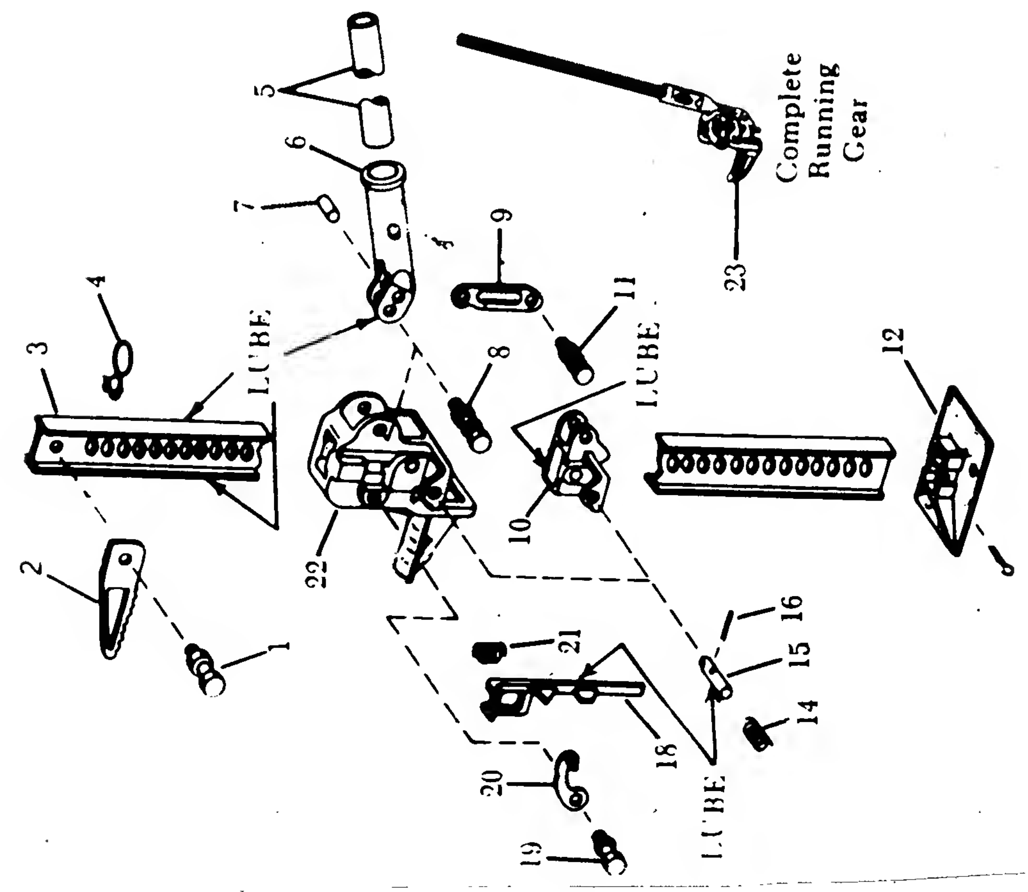

Exhibit 1 (page 4 of 4): Exploded view of jack (enlarged) with identifying parts list (retyped for clarity) on back side of Operating Instructions allegedly supplied with the jack.

When I removed the jack from the shipping case, I placed the base plate (12) on the floor and put the bottom end of the steel standard (3) in the socket in the base plate. I then put the running gear assembly (23) on the standard. In the process of doing this, I saw a decalcomia on the handle (5). The content of this decal has been typed for easier reading in Exhibit 2.

I then put the jack assembly in position with the top clamp clevis (2) under a heavily loaded workbench in order to test the operation of the jack under load. Exhibit 3 shows the jack in operating position with the reversing latch (20) in the UP (raise load) position with the handle upright. Exhibit 4 shows the jack in operating position with the reversing latch in the UP position and the handle "horizontal," in position to start the act of actually raising the load. Exhibit 5 shows the jack in operating position with the reversing latch in the DOWN (lower load) position with the handle horizontal.

I tried operating the jack in order to get a feel for how this went and how easy, or difficult, it was. While doing this, I was careful to operate in accordance with JACK-IT's operating instructions. The load on the jack is raised or lowered by the two climbing pins (15) alternately supporting the load.

Exhibit 3 shows the jack in the UP configuration. If the handle is raised, the lower climbing pin, passing through a hole in the steel standard (3), supports the load. As the handle is lowered, the bottom half of the running gear (23), stays in place. The upper half moves upward. The upper climbing pin moves outward (toward the viewer). The inner end of the pin (hidden in Exhibit 3) is cut at an angle to the pin axis and slides outward against the upper side of the hole in the standard. As the pin moves outward, it compresses a spring (14) between the frame of the running gear and a cross pin (16) through the climbing pin. As the bottom of the climbing pin clears the bottom edge of the next higher hole in the standard, the spring pushes the climbing pin into the hole. When the handle is raised, the upper pin supports the load while the lower pin is being raised for the next step in raising the load. The lower climbing pin works in the same manner as the upper climbing pin.

To lower the load, the reversing latch (20) is moved from the UP position shown in Exhibit 3 to the DOWN position shown in Exhibit 5. It might be noted that the force required to move the latch from UP to DOWN is noticeably less than required to move the latch from DOWN to UP. This is due to the presence of a reversing switch spring (21). As the load is lowered, the climbing pins alternate in supporting the load. To start lowering, the handle must first be pushed downward to put a climbing pin in proper position. As the handle is then raised, the upper part of the reversing switch (18) pushes against the cross pin in the upper climbing pin, pushing the climbing pin out of the hole in the standard while the lower climbing pin supports the load. On lowering the handle, the upper climbing pin supports the load while the lower climbing pin moves to the next lower hole. In lowering a load, downward force on the handle is required only briefly (and the handle moves through a short arc) before the

climbing pin "clicks" into the next lower position. In raising a load, however, the handle must be moved through a substantial arc before the climbing pin "clicks" to the next higher position. It should be noted that lowering a load requires slightly lifting the load until the climbing pin is positioned in the next lower hole before one can lower the load. Continued force must be applied to the handle to keep it from moving upward as the load is lowered. I made no measurement of the forces actually used.

If, as alleged, Henry Voter moved the reversing latch from UP to DOWN without holding the handle and the handle "flew up" and hit him, there is an obvious question. Could this happen, i.e., does the jack function that way, or in other words, with the jack under load, with the handle horizontal with no one holding it, will switching the reversing lever from UP to DOWN cause the handle to "fly up"? It seems obvious this is an integral part of the examination which John Small wanted. At the same time, knowing it is alleged that a man was seriously injured this way, one must be careful and cautious in trying the find the answer.

I was careful and determined that the jack on which Henry Voter was injured did, indeed, have a handle which "flew up" when the jack was under load and the reversing latch was switched from UP to DOWN. I also found this did not occur each and every time. Most times the handle would "fly up" but other times it stayed horizontal. I was convinced, however, that it was possible that Henry Voter could have been injured in the manner alleged.

This test simply confirmed for me (and John Small) what we already knew from reading the Operating Instructions (Exhibit 1). There is a "Safety Precaution" in those instructions which makes it quite clear that JACK-IT was well aware of the propensity of the handle to move and strike the user.

[Much later, as the case developed, John Small sent me a brand new, unused duplicate jack. I did similar testing on this second jack. It operated in the same manner as the original jack when using it according to the manufacturer's instructions. I also found that the handle on the new, unused, jack "flew up" from the horizontal position every time the reversing latch was switched from UP to DOWN. The new jack also had a label on the handle. This was very similar to the one shown in Exhibit 2 but there were some differences. The label on new jack is shown in Exhibit 6.]

John Small had been specific that he did not want a written report until we had discussed my findings. Having done the above testing, I called John Small and told him what I had found. Although I was certain John Small would want suggestions on redesign to eliminate the problem, or if that was not possible, add-ons or retrofits to provide safety for the operator, I was not ready to make such suggestions yet. <u>What one seeks is a simple, effective and inexpensive solution</u>. I had learned from long experience not to trust the first thought that comes to mind. The first idea may, indeed, turn out to be the best. Fairly often, however, the first idea may be sort of a Rube Goldberg and not nearly as good as a solution which develops from thinking over some period of time while comparing and assessing various ideas which occur.

WARNING
CAUTION

READ BEFORE
USING JACK

To prevent injury

Put handle in upright position before tripping Reversing Latch
Always keep firm grip on Jack handle when operating Jack
Lubricate all working parts and edges on steel standard
Place complete lifting nose of Jack under object to be lifted
For additional safety use Bumper Lift to raise one wheel of auto
Always chock, block & stabilize load to be lifted as Jack will not stabilize load
Jack must be on level firm surface in a vertical position
Never work under a raised load unless use additional supports and insert 1/2" bolt through hole in steel standard immediately below lifting mechanism
Never push lifted load off Jack
Never attempt to repair Jack while Jack is under load
Shear pin breaks & handle drops rapidly if exceed 7000 lbs. capacity
If shear pin breaks use a heavier duty Jack to resume lift
Jack must be loaded 100 lbs or more to lower step by step
Max. Capacities: 7000 lbs for all sizes except upper 20" of 60" Jack limited 4000 lbs. Top handle for winching/hoisting equals 5000 lbs. & for clamping equals 750 lbs.

All warranties void if extender on handle is used

DO NOT REMOVE THIS
LABEL

THIS PRODUCT IS COVERED BY ONE OR MORE OF THE FOLLOWING PATENTS, PATENT PENDING OR TRADEMARK REGISTRATION USA NO. D#######, D#######, CAN NO. ######, NO.#######

Exhibit 2: Copy of the wording on a warning decalcomania located on the jack handle where it was readily apparent to a user. The two top lines are in upper case letters, yellow on black, in 9 point print. The next two lines are in upper case letters, black on yellow, in 4.5 point print. The body of the text is in lower case letters (except for capitals), black on yellow, in 6 point print. The lines below the body (DO NOT ------) are in upper case letters, black on yellow, in 4.5 point print. The last lines, are in upper case letters, black on yellow, in 3.4 point print. [A "point" is essentially 1/72 inch or 0.035 mm]

Exhibit 3. Portion of jack showing the running gear with the reversing latch in the UP (raise) position. Handle is vertical. The load is raised by moving the handle downward through an arc. To lower the load, the latch is rotated about its pivot point (left side of latch) by pushing downward on the short section perpendicular to the main portion of the latch at the right of the latch. (See Exhibit 5.) The handle should be kept vertical while using the reversing latch.

Exhibit 4. Portion of jack showing the running gear with the reversing latch in the UP (raise) position. Handle is horizontal. A downward force on the handle will raise the load. When the handle is in this position, moving the reversing latch from UP to DOWN can cause the handle to "fly up," i.e., move upward through an arc about the pivot point at the left (bottom) end of the handle.

Exhibit 5. Portion of jack showing the running gear with the reversing latch in the DOWN (lower) position. Handle is horizontal. A downward force on the handle will raise the load enough for the lower climbing pin to enter a hole in the standard. An upward force will then lower the load the distance of one hole spacing.

DANGER

IMPROPER USE OF THIS PRODUCT IS EXTREMELY HAZARDOUS

WARNING CAUTION

READ BEFORE USING JACK

USE ONLY AS DIRECTED ON LABEL & IN OPERATING INSTRUCTIONS

To prevent injury

Place handle in vertical, full upright position, parallel to upright steel standard before tripping reversing latch or when Jack is under load. When not operating the handle it should be in the full upright position parallel to the steel standard.

Always keep firm grip on Jack handle using both hands when operating Jack. Failure to do this could allow handle to move rapidly upward striking operator and cause possible injury.

Lubricate all working parts and edges on steel standard before using Jack.

Place complete lifting nose of Jack under object to be lifted

For additional safety use Bumper Lift with the Jack to raise one wheel of a vehicle.

Always chock, block & stabilize load to be lifted as Jack will not stabilize load

Jack must be on level firm surface in a vertical position before lifting

Never work under a raised load unless use additional supports and insert 1/2" bolt through hole in steel standard immediately below lifing mechanism

Never push lifted load off Jack

Never attempt to repair Jack while Jack is under load

Safety shear pin breaks & handle drops rapidly if exceed 7000 lbs. capacity

If shear pin breaks use a heavier duty Jack to resume lift

Never replace Safety Shear Pin with a bolt of higher strength. Replace only with manufacturer's Part SP-13 Safety Shear Pin

Jack must be loaded 100 lbs or more to lower step by step

MAX. CAPACITIES: 7000 lbs for all sizes except upper 20" of 60" Jack limited 4000 lbs. Top Clamp-Clevis for winching/hoisting equals 5000 lbs. & for clamping equals 750 lbs.

ALL WARRANTIES VOID IF EXTENDER IS USED ON HANDLE OF JACK OR IF JACK IS MODIFIED OR USED BEYOND RATED CAPACITIES

DO NOT REMOVE THIS LABEL

Exhibit 6: Copy of the wording on the decalcomania on the handle of a new (duplicate) jack. Top line is white on red, 11 point. Second line is red on white, 9 point. Third line is yellow on black, 9 point. Fourth line is black on yellow, 6.8 point. Fifth line is black on yellow, 4.5 point. Body of text is in lower case letters (except for capitals), black on yellow, 6 point. Line - All warranties --- is black on yellow, 4.5 point. Last line is black on yellow, 6.8 point. [A "point" is essentially 1/72 inch or 0.035 mm.]

During our phone conversation, John Small told me that he also had another expert, Dr. Jim Julio, examine the jack. I inferred that he had wanted to see just how much we agreed upon without reference to each other. Even though one might consider this a bit demeaning or embarrassing to each of the experts, it seems to me this is a canny or savvy approach; one which tells me that I have a good lawyer as a client. He promptly volunteered that he would send me the results of Dr. Julio's investigation. [It may be of interest that Dr. Julio was in a city about 200 miles from me and thus much closer to JACK-IT than John Small.]

Dr. Julio operated the jack and reported: "We conducted a test of the jack with a load of about 1500 lb (6670 N). We found that a force of about 35 lb (155 N) was required at the end of the handle to raise the load. This same force was required briefly to release the load when lowering, while a force of about 20 lb (90 N) was required at the end of the handle to control the load once it was released for lowering.

"This all-purpose jack works much the same way as most any mechanical jack. As the jack was being operated to lift a weight, there was little problem. A large force was needed to push down on the lever arm to raise the load. As the climbing pins clicked to the next higher slot, the load would no longer be on the lever arm itself. The potential danger exists when one begins to lower the load. As a force is exerted down on the lever arm, the climbing pins move down to the next lower slot of the jack's spine. As this occurs, the weight on the jack's load point forces the lever arm to fly up. The rate at which this movement occurs depends on various factors. One is the actual weight of the load; a larger load will cause the lever arm to spring up faster. Another factor is the force one maintains on the lever arm while the weight is being lowered. A strong, firm grasp will not cause the arm to fly up, while a loose grip may not be able to control the force exerted from a large load. All jacks similar to this specific jack operate in the same basic manner. It is unavoidable that the lever arm will be forced up as the load is being lowered. Thus users must be made aware through instruction manuals, warning devices, etc."

John Small had also requested that Dr. Julio perform a readability analysis of the operating instructions. Readability analyses are measures of how effectively a piece of writing communicates a message to the reader. He wrote: "We calculated the Flesch-Kinkaid Grade Level Index (perhaps the most frequently used index) which produced an index of nine (9). This formula takes into account average sentence length and average number of syllables per word. This is higher by at least three grades than it should be for the intended audience. The U. S. Army, for example, requires a level of six for manuals and other materials that its field personnel use.

"If we were to rewrite this material, we would do at least the following:

1. Reduce the number of words with three or more syllables.
2. Change passive voice to active voice.
3. Reduce the number of long sentences. (There are five

sentences that contain more than 30 words.)
I would expect these three steps alone to reduce the Flesch-Kinkaid index to six or less. While more multi-syllabic words, longer sentences, more subordinate clauses, etc. may make written material appear to be more erudite, profundity is not needed in instructions on an implement such as this."

Dr. Julio also examined the warning label (Exhibit 2) and commented: "The warning label on this jack is inadequate and should be rewritten. A user may become discouraged with the current label because of the small print and thus not read it, missing some important safety practices. It is probable that the current label has small print because of the round lever arm. Larger letters would cause the label to wrap around the arm more and increase the difficulty in reading the label. Of equal concern, it seems as if this label is trying to serve as both a warning label and an instruction manual. What results is a list of precautions that are not of the same magnitude of importance." Dr. Julio further recommended using two labels; One being a warning label advising of potential hazards and a second one of safety instructions.

As I indicated earlier, I had made no measurement of the forces necessary to operate the jack. My sense of the forces I used seemed consistent with those reported by Dr. Julio. I found the readability analysis very interesting. I had been aware for a long time that a major problem in equipment design was writing warnings, instructions, etc., in such a manner that the potential user could readily understand them. I was aware that the sixth grade criterion was widely used by lawyers. I had been delighted to find a book by Klare [The Measurement of Readability, Iowa State University Press, 1963] which contains a number of readability indices. While I did not make the effort to confirm Dr. Julio's readability analysis, I am sure I will find Klare useful in the future.

I believed the print in the Operating Instructions (6 point) and the warning labels (Exhibits 1, 2 & 6) was too small. It appears that Dr. Julio agreed, although perhaps for somewhat different reasons. I know that ANSI Standard Z535.4 [American National Standard for Product Safety Signs and Labels, 1991] specifies requirements for colors and wording on safety signs. The colors on the label in Exhibit 6 do conform to the standard. This same standard specifies letter size, i.e., signal words must be at least 3mm high (9 point) and text must be at least 1.5 mm high (5 point). These two items related to this jack do conform to the minimum in this standard. One needs to remember, however, that this is a consensus standard and represents the minimal requirements acceptable to those involved in developing the document. There are many, including me, who believe the lettering should be larger. Bailey [Human Performance Engineering: A Guide for System Designers, Prentice-Hall, 1982] says that "type size in books and magazines usually ranges from 7 to 14 points with the majority being about 10 to 11 points. Probably the optimum range is from 9 to 11 points - sizes smaller or larger can slow reading speed."

I was aware, however, of nothing that Dr. Julio had suggested with regard to redesign to prevent the handle from "flying up."

It is obvious that the jack handle will "fly up" when the horizontal and the reversing latch is switched from UP to DOWN. Dr. Julio and I individually determined that. JACK-IT was certainly aware as is obvious from the operating instructions and warning labels.

The major question then is: Are the Operating Instructions and warning label sufficient or must one either redesign the jack or design a retrofit device (if possible) which will minimize (preferably eliminate) the hazard of the handle flying up? The generic answer is that a design should eliminate any hazard. If this is not possible, then proper guarding to protect against the hazard must be designed. If neither of these can be done, only then are warnings acceptable.

When I talked with John Small, I discovered he had asked a third expert, Mr. Jones (who lived near Mr. Small's city) to make recommendations on methods or mechanisms which could be utilized to make the jack safer. I had concluded there was no simple way to modify the existing mechanism to prevent a horizontal handle from flying up when the jack was under load and the reversing latch was moved from UP to DOWN. I did, however, believe the situation could be greatly improved. Between us, i.e., Mr. Jones and me, three suggestions resulted.

1. A hole could be drilled through the reversing latch and the upper part of the running gear. A pin should be inserted through the hole in both pieces when the reversing latch is in the UP position. This pin would be attached to the running gear by a chain to avoid losing it. Once the pin was inserted, the reversing latch could not be moved to the DOWN position until the pin is removed. This would also require an instruction to the effect of (a) inserting and removing the pin and (b) firmly holding the handle down when moving the reversing latch to the DOWN position.

2. A toggle could be placed between the reversing latch and the running gear. When the reversing latch was moved to the UP position, the toggle would automatically open (or spread) and hold the latch in position against inadvertent reversing. A small pull on the toggle would release it and allow the reversing latch to be changed to the DOWN position. An instruction to the effect of holding the handle while doing this would be needed.

3. Exhibits 7 and 8 show a retrofit design. There is no way the reversing latch can be moved to the DOWN position while the handle is horizontal (Exhibit 7) but it can be moved when the handle is vertical (Exhibit 8).

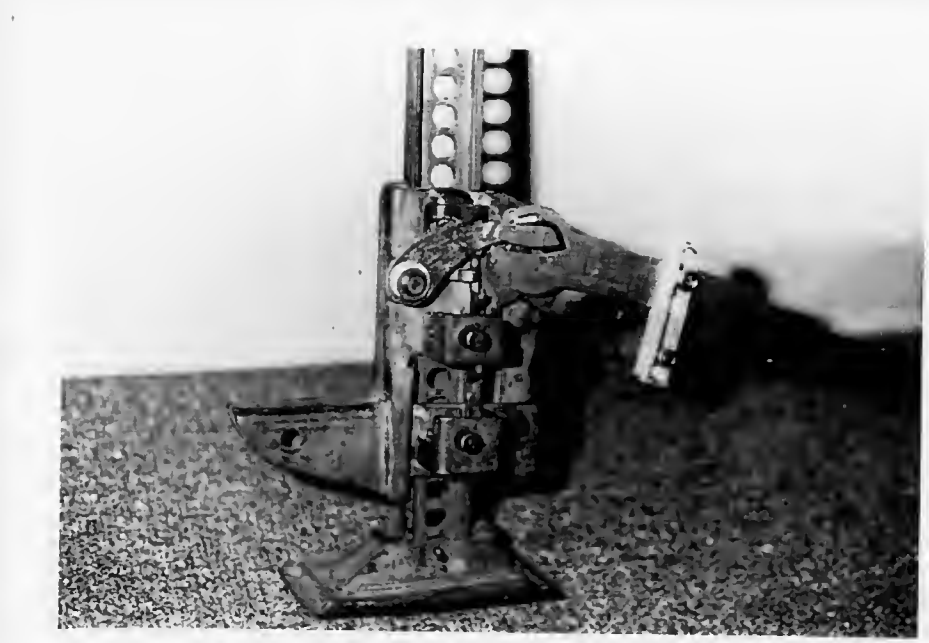

Exhibit 7. Jack showing a retrofit which prohibits moving the reversing latch from the UP to the DOWN position when the handle is in a horizontal position. This prevents the handle from inadvertently flying up.

Exhibit 8. Jack showing a retrofit which allows moving the reversing latch from the UP to the DOWN position when the handle is in a vertical position. Since the handle is vertical, it can not fly up when the reversing latch is moved from UP to DOWN.

JACK - A MECHANICAL MUGGER?

Presumably, every writer of a case has at least one (often more) pedagogical objective in mind. If not, why write the case? The user of a case for classroom purposes may sense that objective but may well have something different which the Instructor considers more important in the context of the course. If so, that is how the case should be used. An Instructor's Note, therefore, should not be construed as implying, much less dictating, how a case ought to be used. The Note is intended to make suggestions for use, supply information that may be useful but which the writer does not want to put in the case proper. This case is written in four parts to permit greater flexibility in its use. Use, and enjoy! If the Note is helpful - great!

The designer/manufacturer of any product has the obligation to make the product safe, i.e., reduce the associated danger to an acceptable level. In this context, safe means a product with an irreducible minimum of danger (as defined in the legal sense), i.e., safe not only with regard to intended use (or uses) but also all unintended, but foreseeable, uses. There are three aspects, or stages, in designing for safety.

1. Make the product safe, i.e., design all hazards out of the product.
2. If it is not possible to design out all hazards, provide guards which eliminate the hazards.
3. If it is not possible to provide proper and complete guarding, provide appropriate directions and warnings.

Directions are instructions intended to ensure effective use of a product. Warnings, in contrast, are intended to ensure a safe use, i.e., to inform of hazards, of improper use, and instruct how to guard against these, if possible. The distinction is clear in concept but it is not always possible to tell whether a given statement is a direction or warning. There are three criteria which must be met for a warning to be fully effective (these also apply to directions):

1. The message must be received.
2. The message must be understood.
3. The endangered person must act in accordance with the message.

A WARNING IS NOT EFFECTIVE UNLESS IT CHANGES THE POTENTIAL BEHAVIOR OF THE ENDANGERED INDIVIDUAL.

To rephrase for the sake of emphasis: The courts have generally held that any manufacturer has the obligation to produce a device free from any safety hazard when the device is used for its intended purpose or for any unintended, but foreseeable, purpose. It is also generally recognized that even the safest possible device, or the best possible guarding, which the designer can conceive may, in some cases, not be totally effective or may severely impair the intended function of the product. In such a situation, the designer is obligated to provide appropriate warnings.

Part A

Why does John Small want an engineer who is far from Small's office but near the JACK-IT plant? [The primary reason was to be able to use the argument that JACK-IT sought no qualified outside professional help even when it was available within a reasonable distance and JACK-IT recognized there was a problem. Sort of a negligence type of argument.]

With regard to the Operating Instructions, JACK-IT claimed that a copy of these was put in an envelope and attached with a small wire to each jack shipped. What is the probability this is true? [Fairly high but there is no guarantee that this will always happen.] Assuming this is true:

What is the probability that a user of the jack will see them (a) when the jack is new, (b) when the jack has been in use for some time?

If the user does see them, will the user read them?

If the user reads them, will the user understand them?

If the user does understand them, will the user follow them?

[One person's estimate of these probabilities is likely to be as good as any other person's. The overall probability, however, is very low.]

Do these same questions apply to warning labels? [YES]

What is the reaction to these Operating Instructions, e.g., print size, readability (i.e., ease of reading and comprehending), etc.? [Relative to these two questions, there is comment in Part C. In addition: It was noted above that the operating instructions were shipped with the jack. It is generally recognized, however, that unless such instructions are permanently attached to the appropriate item of equipment, these instructions are rarely seen by the operator. It is rather common practice for the receiving department to remove them and turn them over to an "appropriate office" for storage. Sometimes they are removed and thrown away. Even if permanently attached in some manner, there is no guarantee an operator will see them, or having seen them, will read them, or having seen and read, will understand (truly comprehend) and follow them. Likewise, with warning labels, no matter how well written and obvious, there is no guarantee an operator will see them, or read them, or understand, or observe them.]

With the information given, principally in Exhibit 1, can students determine how the jack operates?

Do students perceive that this accident could have happened as alleged? Do they see there is a problem needing the attention of an engineer? If so, what do they see as the problem?

How do students think they should proceedd, i.e., what information is necessary, or what steps need to be taken?

Part B

What is the significance of "points" in Exhibits 2 and 6? What is the reaction to the print size in these two Exhibits? [See Part C for comment. Recognizing that the print size in the Operating Instructions (Exhibit 1) is 6 point may provide insight.] What is the

reaction to the content of these labels, i.e., are they really focussed on important matters? Do students have difficulty comprehending the contents? Do students perceive these labels to be effective? Why or why not?

What is the significance of the changes from Exhibit 2 to Exhibit 6? Are these effective? [My best guess is that JACK-IT thought it could solve the problem by an "enhanced" warning. There was enhancement but that is of no consequence if there is a better design which eliminates the problem.]

Even if a manufacturer uses a warning when it is necessary does it stay in place "forever"? [NO. Decalcomanias are commonly used and there are high quality ones available, ones which will adhere for a long period of time, which will resist scuffing, etc. But, there is no evidence they will last indefinitely. Metal plates which are welded or riveted in place have a longer life but even they are not indefinitely impervious.]

Why didn't John Small want a written report? [All material in an attorney's file is "work product" and unavailable to opposing attorneys. An expert's file, on the other hand, is not "protected" in this manner and anything in the expert's file can be "discovered" during the development of the case. In effect, if there is very little in the file and no written report, there is very little to be "discovered."]

Do students recognize that warnings are not sufficient if there is a simple, effective, inexpensive solution which permits operation without a warning? Are they able to propose redesigns or retrofits?

What do students see as the next steps, i.e., what action is appropriate at this point as there is, as yet, no resolution of the difficulty.

Part C

Why all the attention paid to Operating Instructions and warning label when the "real" problem is the handle flying up? [This relates to readability and comprehension on the part of the user. This is an aspect of design to which very little attention is paid. There needs to be much more emphasis on this in the classroom, principally for future consideration when students are in professional practice.]

What reasons do the students see for the size print used on the Operating Instructions and warning labels? Since the warning label seems to meet the ANSI standard for colors and print size, is there any reason to question the size print? Why or why not?

This section of the Case gives an opportunity to explore standards. There are more than 35,000 documents (standards) which have been generated by nearly 350 standards-writing organizations in the US. ANSI is one of the better known of these organizations. One can explore what standards are, how they are generated, how they are used, what legal standing (if any) they have. Students need to be exposed to some minimum of information relative to standards.

If students have concluded there is no "mechanical fix" to resolve the problem, is the presence of Operating Instructions and a warning label sufficient? Are the Operating Instructions and warning

label adequate? Why or why not? What about Dr. Julio's suggestion of two labels?

If students have not yet developed conceptual solutions for providing a resolution of the "flying" handle, are they ready to do so now? If so, what are their proposals?

What steps or actions, if any, remain to obtain a resolution? Outline them.

Part D

How do student proposals for redesign and/or retrofit compare with those proposed in Part D?

Critique and compare the three options given. [My comments on the three options:

1. This would be effective, IF the user complied. As with any warning or instruction, there is no guarantee that the user would read the instruction or, if read, that the user would comply. While this might help, it would not be completely effective.

2. This seems to be more effective than No. 1 as no action is required of the user to lock the reversing latch. The user must take action to be able to reverse the latch. This is no guarantee, however, that the user would read the instruction or would hold the handle to prevent it flying up.

3. One could argue that the arrangement shown could be removed by the user. As shown in Exhibits 7 and 8, that is true but these exhibits are for demonstration only. A retrofit as shown in Exhibits 7 and 8, applied to the handle of this model jack, would certainly be attached in a much more permanent manner. This might be done (1) by welding or (2) by drilling and tapping two (or more) holes in the handle and using machine screws which can be screwed in, but not reversed, using a screwdriver. The jack could be modified in a similar manner during manufacture at the plant.

These three are arranged in perceived order of effectiveness. No. 3 seems to be simple, effective, and inexpensive and thus would appear to be a desired solution. There might well be other possibilities.]

Students usually want to know the outcome, or resolution, of a litigated case such as this. The case was settled out of court with the sum of $390,000 being paid to Henry Voter.

It is not known what action, if any, JACK-IT took to make any changes in its jack. One would hope a change would have been made.

On the subject of warnings, a couple of references might be helpful. A rather condensed version is: Smith, C. O. and T. F. Talbot, "Product Design and Warnings," ASME Paper 91-WA/DE-7. Probably the most comprehensive coverage of warnings is given by: Lehto, M. R. and Miller, J. M., "Warnings: Volume I, Fundamentals, Design, and Evaluation Methodologies," and "Warnings: Volume II, An Annotated Bibliography", Ann Arbor, MI, Fuller Technical Publications, 1986

Another reference is Chapter 10, "Safety," Standard Handbook of Machine Design, 2nd Ed., McGraw-Hill, To be published in late 1995 or early 1996.